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National Marine Fisheries Service
SOUTHWEST REGION
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INVENTORY OF EELGRASS (*Zostera marina* L.) IN SAN FRANCISCO/SAN PABLO BAY

by

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OCTOBER 1989

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Executive Summary

Eelgrass, *Zostera marina*, is an aquatic plant known to be an integral component in the ecology of lagoons and estuaries along the Pacific Coast. Since eelgrass requires adequate light to grow, turbidity within the San Francisco Bay estuary limits eelgrass to shallow nearshore areas. One problem facing resource managers in the bay area is shoreline development, including fill projects and in-bay disposal of dredge spoils, that eliminates habitat or adversely affects water quality.

To aid resource managers and inform developers, the National Marine Fisheries Service, Habitat Conservation Branch conducted a survey of San Francisco and San Pablo Bays to document the existence and map the location and acreage of eelgrass beds in the estuary. The study, conducted in the fall of 1987, combined technologies ranging from diver surveys to fathometer mapping of identified beds.

Results of the survey indicated that there were 316 acres of eelgrass in San Francisco and San Pablo Bays. Since no survey of this nature had been done before, a historical comparison of acreages and growth trends cannot be made. However, compared to other estuaries where eelgrass is found in Northern California (Tomales Bay, Albion River, Humboldt Bay), field observations indicate eelgrass distribution is patchy and, at certain beds, stressed. One of the most important aspects of this survey is its provision of a preliminary baseline for future studies on the fisheries utilization and eelgrass habitat trends in the San Francisco Bay estuary.

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INTRODUCTION

Eelgrass, **Zostera marina**, is an aquatic flowering plant that inhabits the shallow subtidal and intertidal regions of lagoons and estuaries. These plants are distributed discontinuously throughout coastal waters of the northern hemisphere (McRoy 1968). The range of eelgrass on the western side of North America extends from Baja, California to Alaska (den Hartog 1970). Biogeographic studies by McRoy (1968) in Alaska and Phillips (1984), British Columbia to Humboldt Bay, northern California, are the only comprehensive West Coast studies appearing in the literature. Localized studies describe eelgrass communities from Humboldt Bay to the Mexican Border, but no systematic work is available (R.S. Hoffman, National Marine Fisheries Service, Terminal Island, CA, pers. comm.).

Seagrasses perform several key functions in the ecosystem. These have been summarized by Zieman (1982) and include the following:

1) High production and growth - The ability of seagrasses to exert a major influence on the marine seascape is due in large part to their extremely rapid growth and high net productivity.

2) Food and feeding pathways - The photosynthetic energy from the seagrass may follow two general pathways: direct grazing of organisms on the living plant material or utilization of detritus from decaying seagrass material.

3) Shelter - Seagrass beds serve as a nursery ground for the juveniles of a variety of finfish and shellfish of commercial and/or recreational importance.

4) Habitat stabilization - Seagrasses stabilize the sediments in two ways: a) the blades slow and retard current flow, reducing water velocity near the sediment-water interface, which promotes sedimentation of particles and inhibits resuspension of organic and inorganic material and, b) rhizomes and roots form an interlocking matrix, which bonds sediment and retards erosion.

5) Nutrient effects - The production and the promotion of sedimentation by the leaves of seagrasses provide organic matter for the sediments and maintain an active environment for nutrient recycling.

A major problem confronting resource managers is the lack of information regarding the location and abundance of eelgrass communities in San Francisco/San Pablo Bays (Figure 1). Constant human activities such as shoreline development, waste outfalls and dredging severely threaten the survival of this valuable plant community (Phillips 1984; Thayer et al. 1984). Scientific

study of San Francisco Bay eelgrass beds has been minimal since the early studies of Setchell (1929) (Nichols and Pamatmat 1988). Knowledge of the bay's eelgrass is essential for resource managers and developers to make responsible decisions regarding potential impacts to these plant communities.

In the fall of 1987, the Southwest Region of the National Marine Fisheries Service initiated a resource inventory of eelgrass in the bay. The project consisted of two objectives: 1) provide a map depicting geographic range and distribution, and 2) estimate total acreage at individual communities (sites) and in the bay as a whole.

STUDY AREA

The San Francisco estuarine complex is the second largest estuary in the nation, consisting of 460 square miles of water surface area at mean higher high water. The ecosystem is extremely complex as a result of both natural and extensive urban influences. It receives runoff from the entire watershed of the Sacramento/San Joaquin Valley basin, approximately 60,000 square miles or 40 percent of California's land area (Nichols and Pamatmat 1988).

Toxic chemicals from agricultural use and over 100 municipal and industrial sources enter the bay and delta continuously. Over one-half of the bay's historic freshwater outflow is lost through diversion. Ninety-four percent of the original tidal wetlands have been filled or diked (Josselyn 1983) and the remainder are threatened by further development proposals.

The San Francisco Bay estuary provides habitat for over 100 species of fish. Common estuarine fishes and invertebrates dependent on the estuary include striped bass, white sturgeon, green sturgeon, chinook salmon, steelhead trout, Pacific herring, Northern anchovy, longfin smelt, topsmelt, white croaker, starry flounder, surfperch, bay shrimp, dungeness crab, English sole, leopard shark, brown smoothhound shark, and spiny dogfish (USFWS 1981). A number of these resources are exhibiting population declines, ranging from mild to severe (Smith and Kato 1979) with notable exceptions being salmon and herring.

The current survey was designed to canvass all areas of San Francisco/San Pablo Bay that possibly could support eelgrass and map the extent of those resources. Survey boundaries were established at the Golden Gate and Carquinez Strait Bridges (Figure 1).

METHODS

Eelgrass Location and Distribution Survey

Initial surveys were performed by helicopter overflights at low tidal stages to determine areas of greatest eelgrass concentrations. Highly turbid waters in the Bays prevented accurate visual delineation of eelgrass beds.

Surveys were conducted by a the boat was equipped with a Sytex HE 106 and Ranger 420 fathometers. Fathometers proved useful in locating submerged vegetation by other researchers (Maceina and Shiremen, 1980; Maceina et al. 1984; J. Spratt, California Department of Fish and Game, Monterey, unpubl.). Since other plant communities occur in the Bays and appear similarly on fathometer recordings (e.g., Gracilaria sp.), it was necessary to identify these communities by snorkeling, benthic grabs or subsequent inspections at extreme low tides.

Estimated Total Acreage

Once the perimeter of an eelgrass community was located and marked, the dimensions of the bed were determined by using a Coleman Rangefinder, Model 1200. The edge of the eelgrass bed was determined by sighting, with the rangefinder, at three fixed points on shore from the boat. Through triangulation, the boat's position was determined. All the beds were measured in this manner. Total acreage was then calculated and field maps prepared.

RESULTS

It appears that most, if not all, eelgrass communities in San Francisco/San Pablo Bay were observed and mapped successfully. Only areas containing eelgrass are illustrated (Figures 2-9). The acreage of eelgrass within the bays are approximately 316 acres. Individual acreage figures for each bed are presented in Table 1.

The northern extent of eelgrass distribution in the Bay complex is in lower San Pablo Bay, near Pt. San Pablo (Figure 2); the southern extent is in South San Francisco Bay, at Coyote Pt. (Figure 7).

DISCUSSION

Eelgrass habitat is a permanent feature of most Pacific Coast estuarine ecosystems. In a well-balanced system, these seagrass communities occupy all niches possessing environmental conditions favorable to the species. However, new communities become established as suitable environmental conditions develop, and established communities will deteriorate as favorable environmental conditions deteriorate (den Hartog 1971).

The loss of eelgrass communities in major estuaries may have far-reaching adverse impacts on other resources. For example, effects of the "wasting disease," a disease that in the 1930's destroyed eelgrass on the east coast of the United States and Europe, were devastating (Short et al. 1986). The population of the sea bird, Atlantic brandt, was severely affected as were populations of commercially fished species such as cod, shellfish, scallops, and crabs (Milne and Milne 1951; Stauffer 1937; Thayer et al. 1984). In the Chesapeake Bay, decline of seagrasses, especially Zostera marina, is well-documented (Orth and Moore 1983). Scientists were quite concerned when similar declines were not evident in other east coast estuaries. They speculated that the declines were related to changes in water quality, specifically eutrophication and turbidity (Orth and Moore 1984). Monitoring the distribution of seagrasses in Chesapeake Bay is important to assess impacts of urbanization on all estuarine resources.

This survey provides developers as well as habitat managers information needed to review water development proposals throughout much of San Francisco/San Pablo Bay. It provides a means to predict when a proposed project might be expected to displace or otherwise impact existing eelgrass habitats. The survey also provides an information base to proceed with future habitat research. Periodic updated surveys will be useful as well in monitoring spatial and temporal changes in existing populations to delineate future trends. Such trends, once identified, could enable researchers to better understand the impacts of natural and man-induced environmental changes.

RECOMMENDATIONS

This survey suggests the importance of conducting periodic inventories to monitor eelgrass habitat trends; the data provide a good baseline. As the human population surrounding and using the bays increases, it is important to know not only the extent but the value of existing eelgrass resources. Hoffman (1986) has described the fishery utilization of eelgrass beds in San Diego Bay, California. However, we have no data regarding the role of eelgrass in San Francisco/San Pablo Bay. Compared to other

sites in Northern California (Tomales Bay, Albion Creek, Humboldt Bay), we find the distribution of eelgrass in the Bay to be extremely patchy. It will be useful to assess the importance of these remaining beds to fish resources. This information, when compared to similar assessments in other estuaries may provide habitat researchers and managers information to set habitat program priorities.

ACKNOWLEDGMENTS

This report was possible only with the assistance of many individuals. Several volunteers assisted with field mapping. These include Mike Nelson, Nicole Lapeyrade, and Mary Helen Garcia. Special recognition is given to John Reguzzoni for his extensive help in the field. The overall project design was assisted by Dr. Robert Orth, Dr. Ronald Phillips, and Robert Hoffman. Special thanks to W. Judson Kenworthy, Southeast Center, National Marine Fisheries Service, for his guidance and consultation. Dr. Ted Hobson, Dr. Jeanette Whipple, Wayne Samiere and Tina Wyllie Echeverria gave valuable editorial assistance. Jim Bybee directed the survey. The National Marine Fisheries Service, Southwest Fisheries Center, Tiburon Laboratory provided space, equipment and general support.

TABLE 1. ACREAGE CALCULATIONS FOR INDIVIDUAL EELGRASS BEDS IN SAN FRANCISCO/SAN PABLO BAY

LOCATION	REFERENCE MAP	ACRES
San Pablo Bay	FIGURE 2	124
Point Orient	FIGURE 3	3
Naval Supply Depot	FIGURE 3	12
Point Molate Beach	FIGURE 3	26
Toll Plaza, East	FIGURE 3	0.5
Toll Plaza, West	FIGURE 3	0.5
Point Richmond, North	FIGURE 3	7
Point Richmond, South	FIGURE 3	4
Richmond Breakwater, North	FIGURE 4	18
Richmond Breakwater, South	FIGURE 4	7
Emeryville	FIGURE 5	13
Alameda	FIGURE 6	55
Bay Farm, North	FIGURE 6	2
Bay Farm, South	FIGURE 6	4
Coyote Point	FIGURE 7	1
Richardson Bay	FIGURE 8	13
Angel Island	FIGURE 9	3
Belvedere Cove	FIGURE 9	5
Point Tiburon	FIGURE 9	1
Keil Cove	FIGURE 9	10
Paradise Cove, North	FIGURE 9	4
Paradise Cove, South	FIGURE 9	3
TOTAL ACRES		316

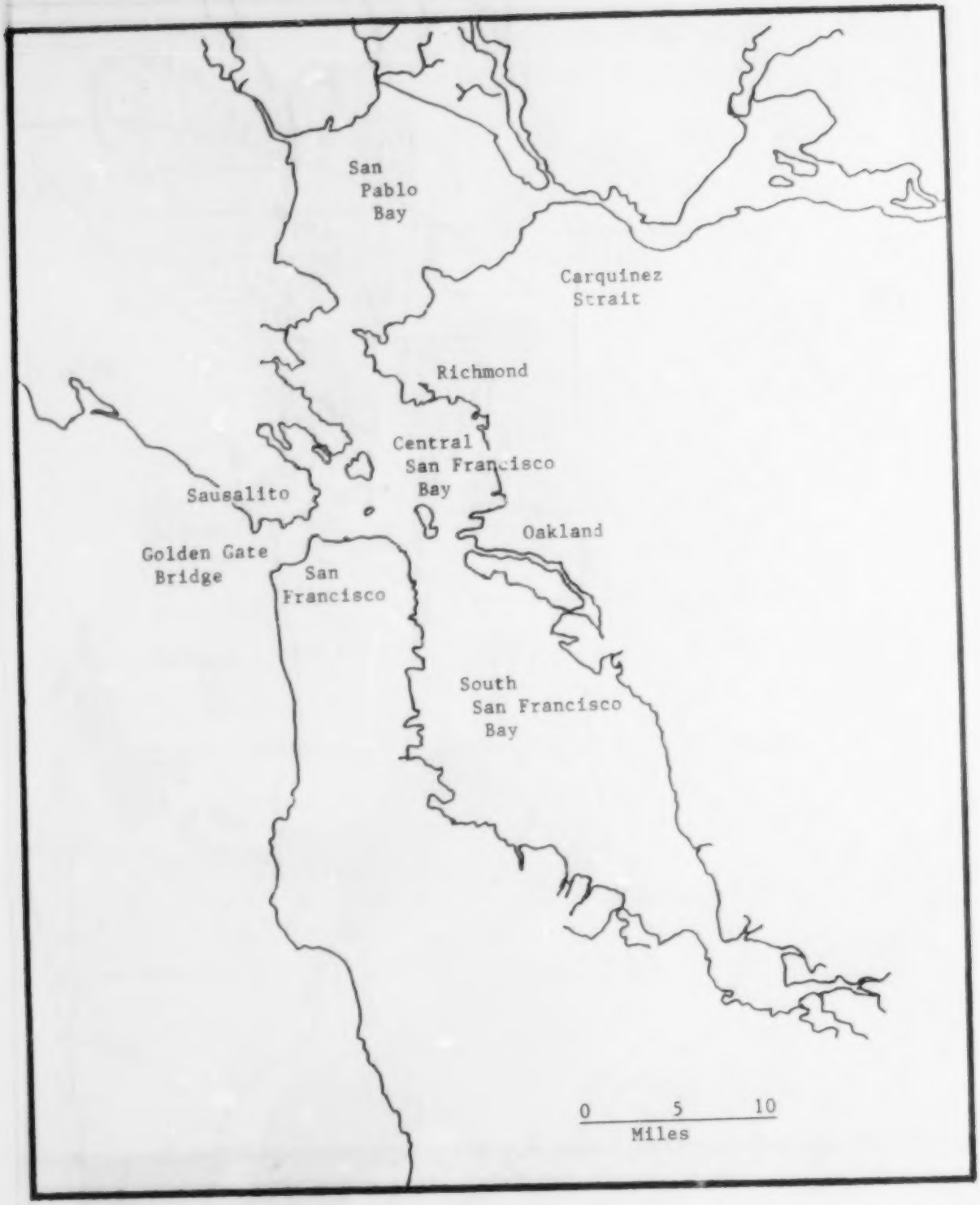

Figure 1. San Francisco Bay

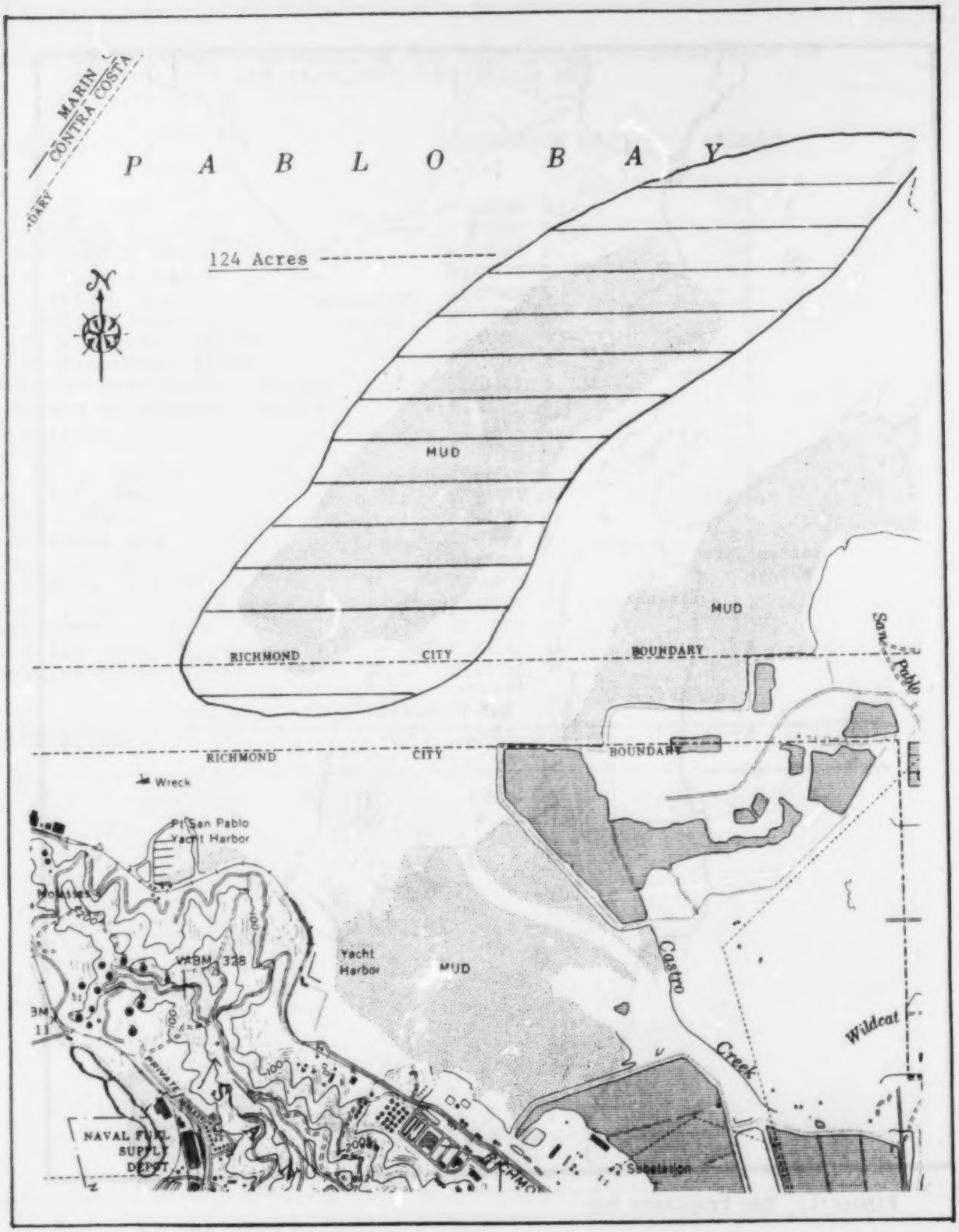

Figure 2. San Pablo Bay

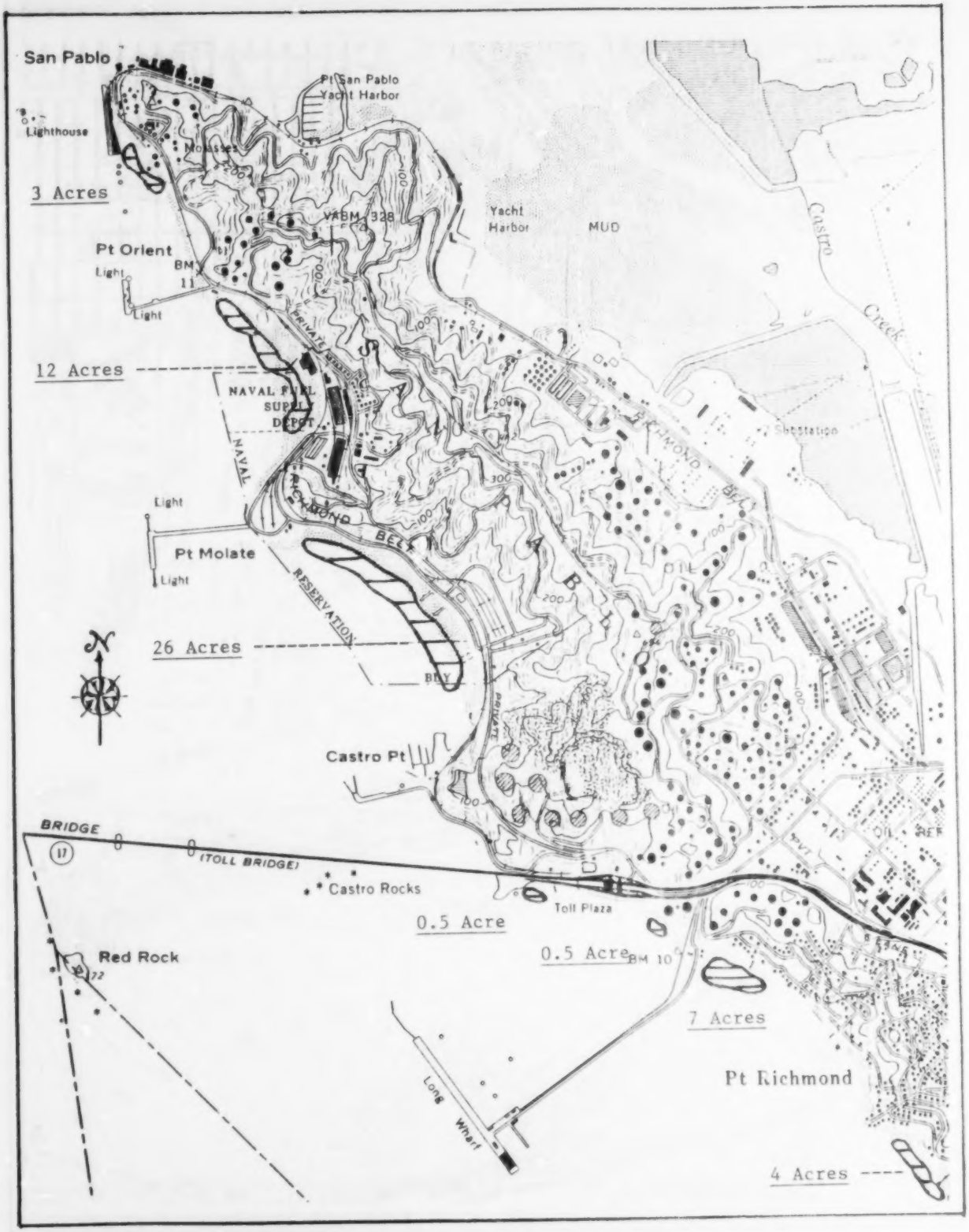

Figure 3. Richmond Peninsula

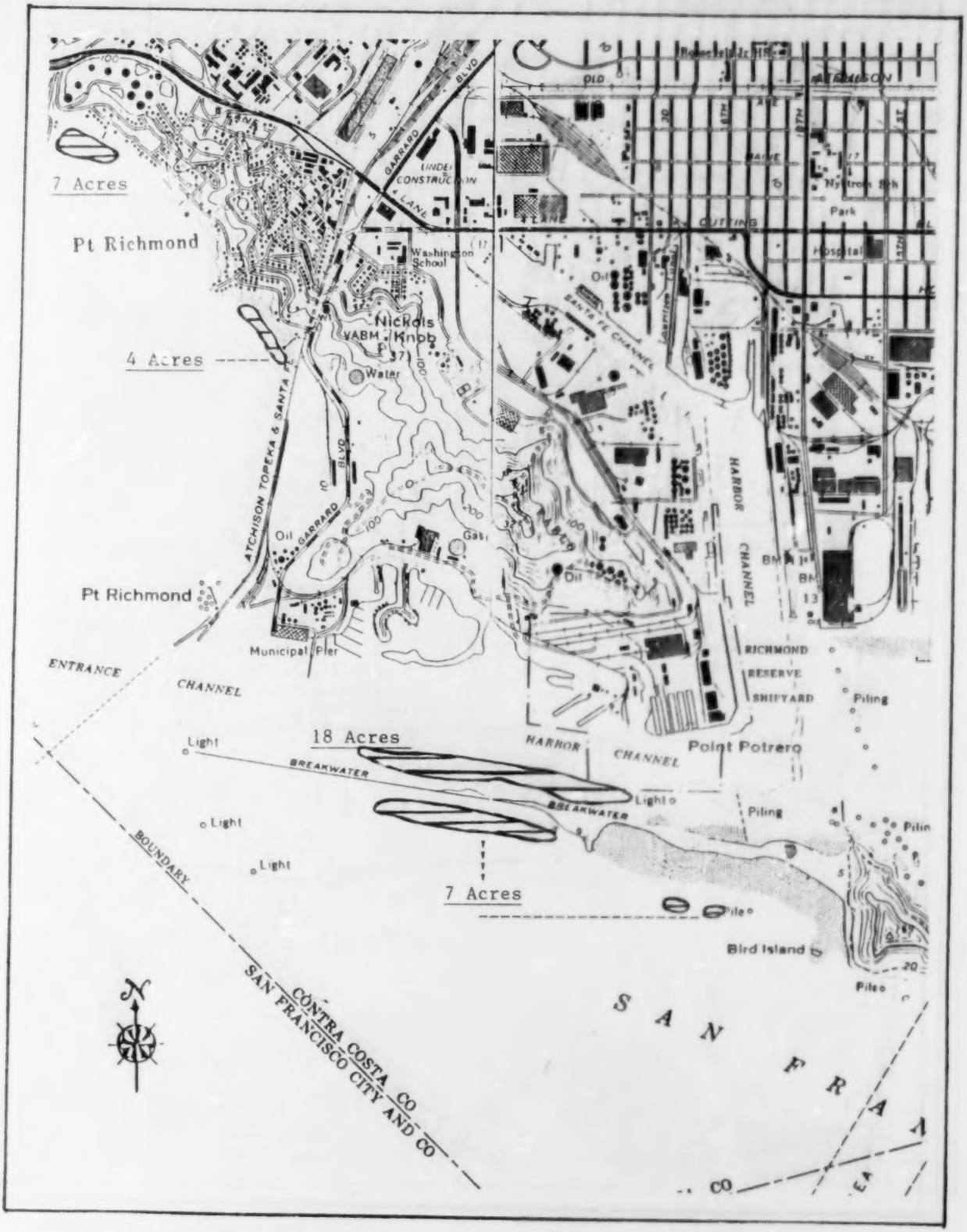

Figure 4. Richmond Breakwater

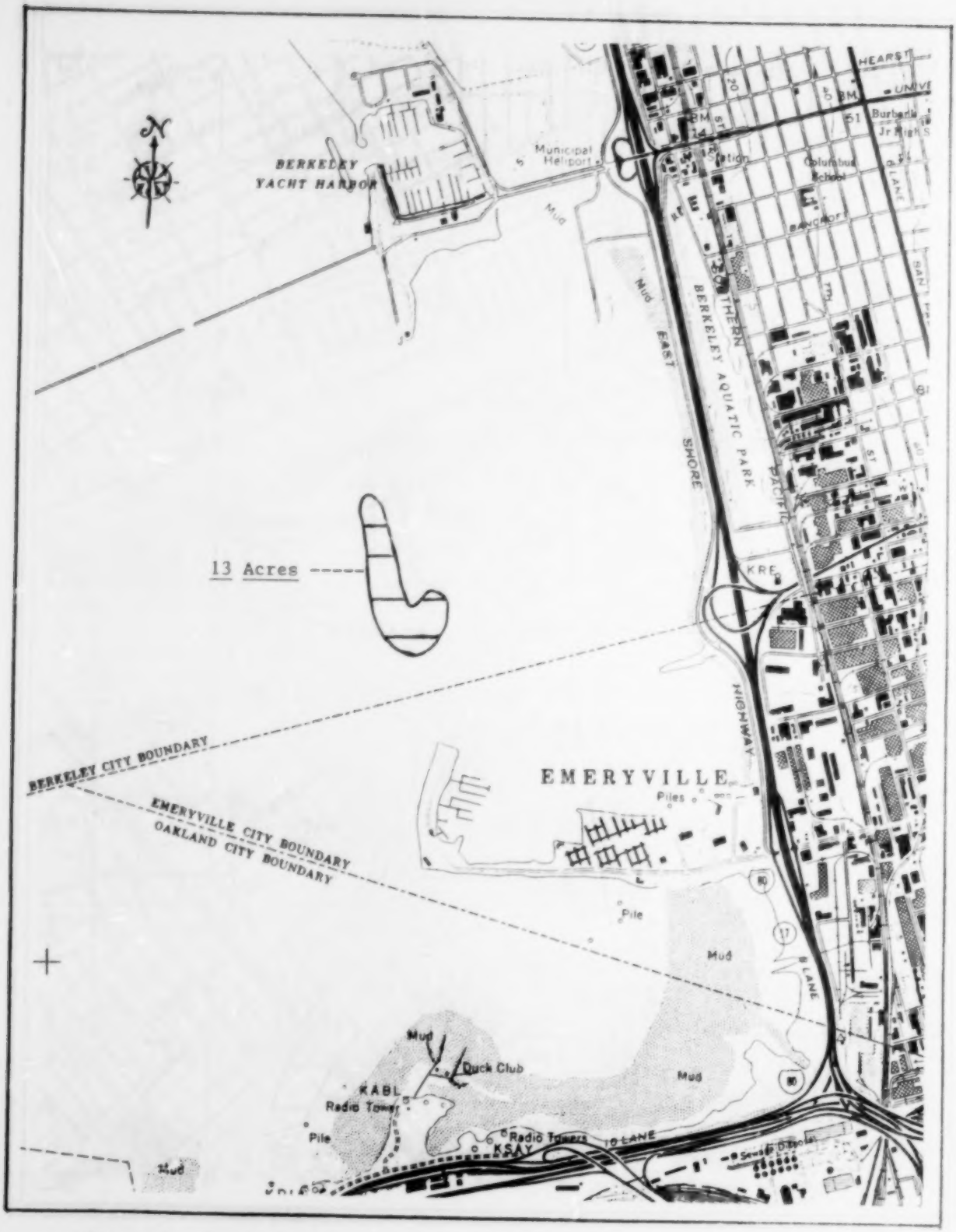

Figure 5. Emeryville

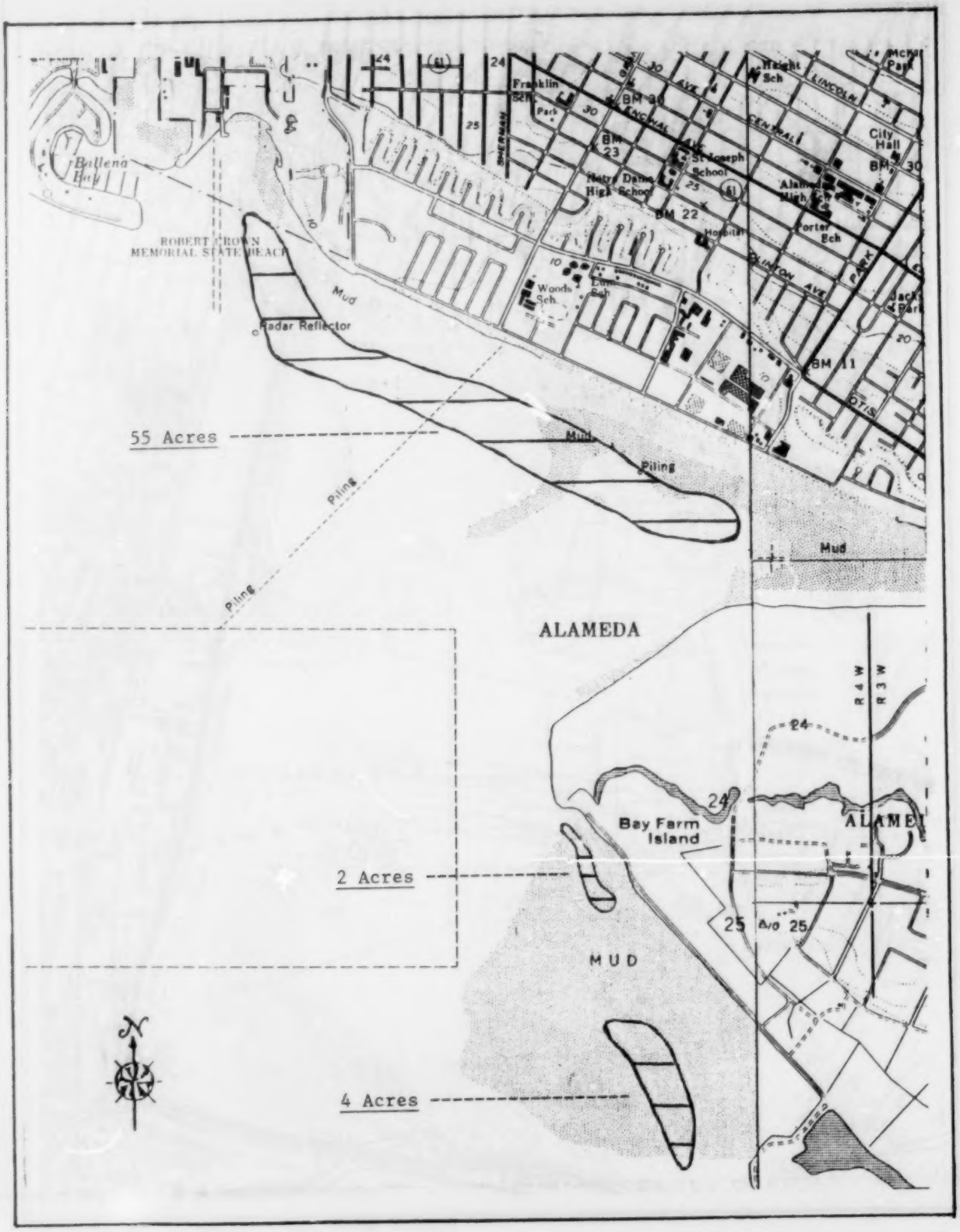

Figure 6. Alameda / Bay Farm Island

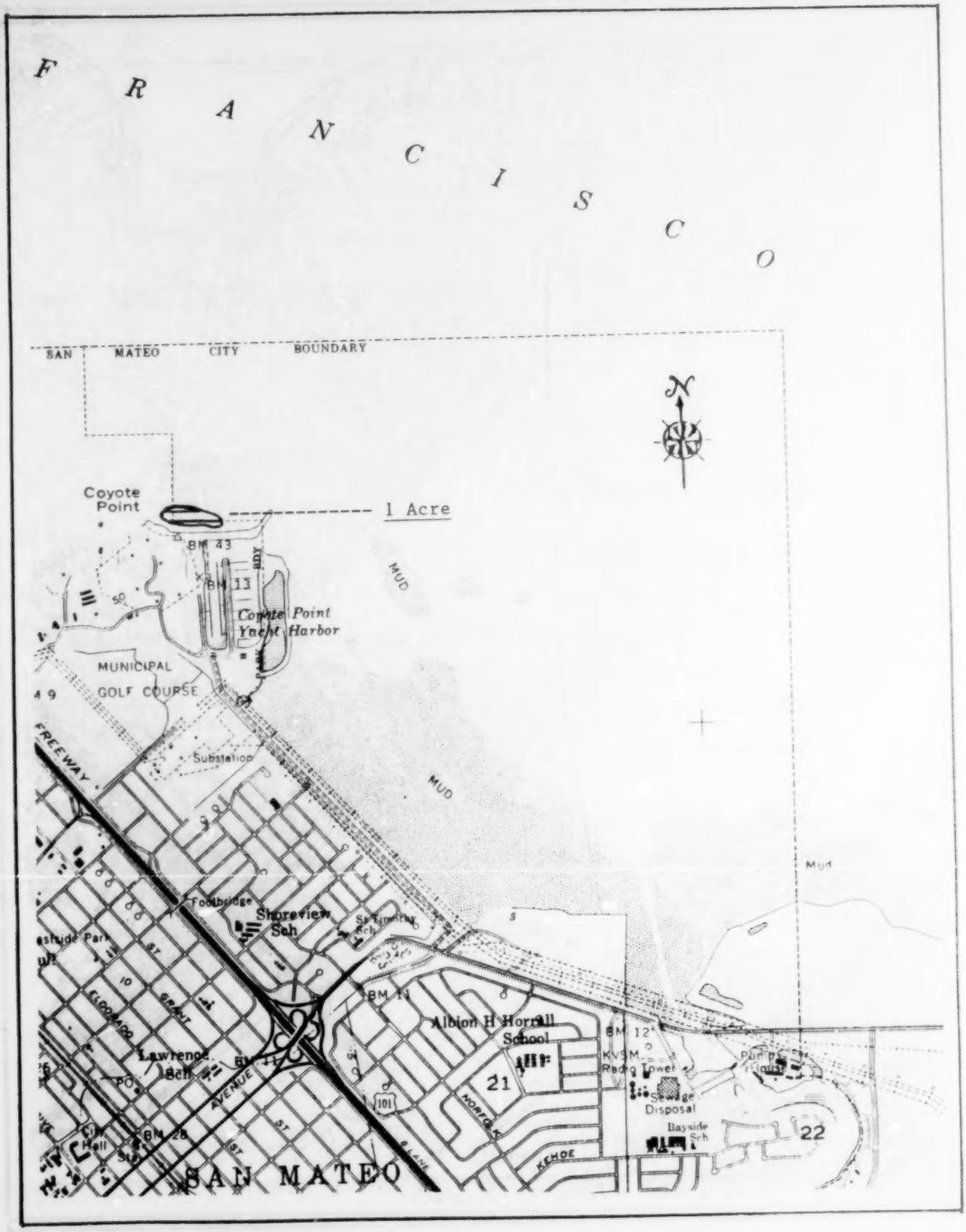

Figure 7. Coyote Point

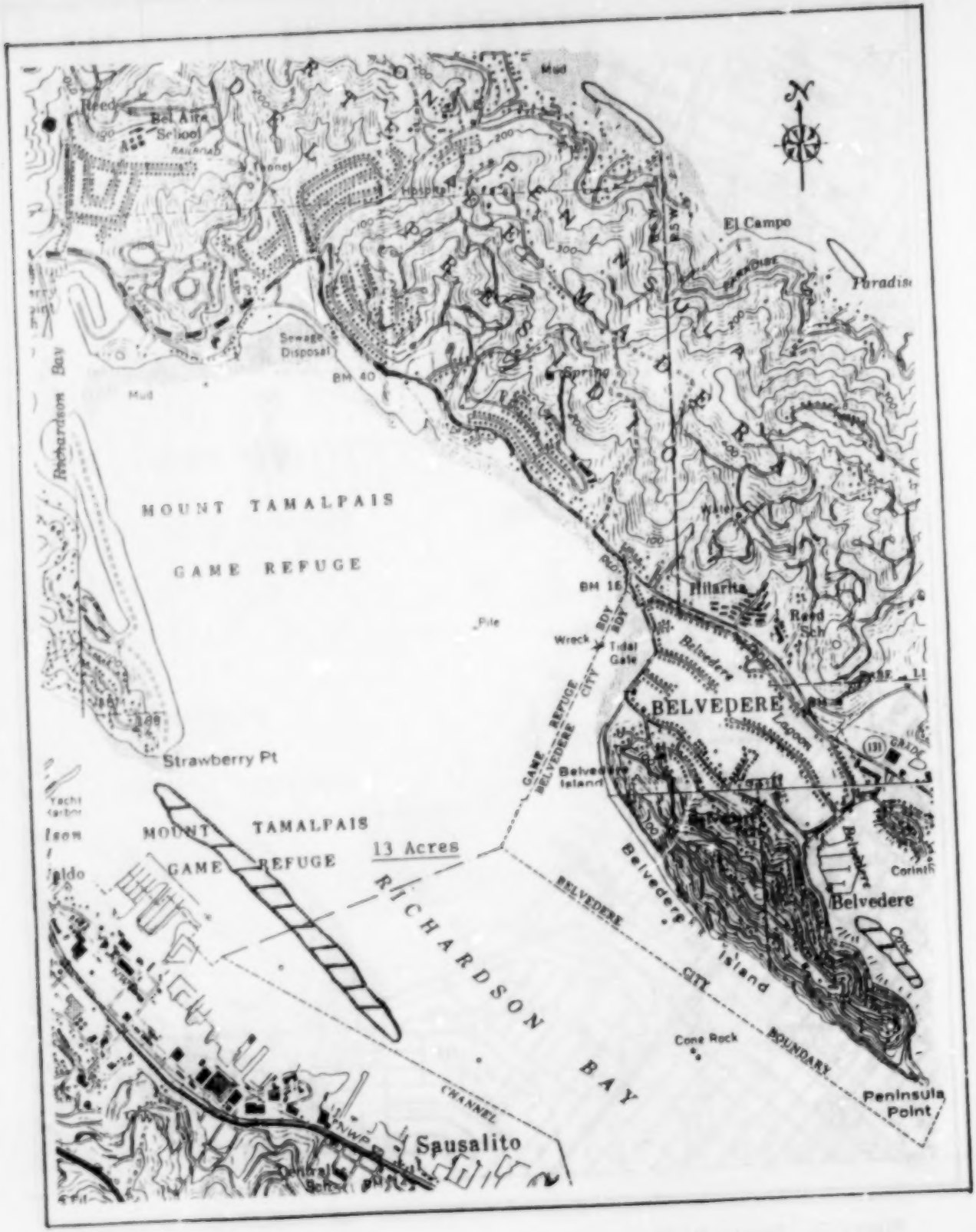

Figure 8. Richardson Bay

Figure 9. Tiburon Peninsula

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